

## REMARKS

Claims 1 to 4, as amended, appear in this application for the Examiner's review and consideration. Claim 5 has been canceled without prejudice. The amendments are fully supported by the specification and claims as originally filed. Therefore, there is no issue of new matter.

Claims 1 and 3 to 5 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Japanese Application Publication No. JP 09 003597 (JP '597), for the reasons set forth on pages 2 to 5 of the Office Action; and

Claim 2 stands rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over JP '597 in view of European Patent Application Publication No. EP 1 221 493 A1 (EP '493) for the reasons set forth on pages 5 and 6 of the Office Action.

In response, Applicants submit that the presently claimed invention is directed to a high-strength thick steel plate excellent in low temperature toughness at heat affected zone (HAZ) resulting from large heat input welding of more than 20kJ/mm. The high strength steel has a thickness of at least 50 mm, and consists essentially of, by weight percent, C: 0.03 to 0.14 percent, Si: 0.30 percent or less, Mn: 0.8 to 2.0 percent, P: 0.02 percent or less, S: 0.005 percent or less, Al: 0.012 to 0.040 percent, N: 0.0010 to 0.0100 percent, Ni: 0.8 to 4.0 percent, Ti: 0.005 to 0.030 percent, Nb: 0.003 to 0.010 percent, and a balance of iron and unavoidable impurities. The amount of Ni and Mn satisfy equation [1]:

$$\text{Ni/Mn} \geq 10 \times \text{Ceq}^{-3} \quad (0.36 \leq \text{Ceq} \leq 0.42) \quad [1]$$

where,  $\text{Ceq} = \text{C} + \text{Mn}/6 + (\text{Cr} + \text{Mo} + \text{V})/5 + (\text{Ni} + \text{Cu})/15$ .

In contrast to the presently claimed high-strength steel plate, the thickest steel plate disclosed by JP '597 has a thickness of only 32 mm, and is welded with a heat input of 105 kJ/cm, i.e., 10.5 kJ/mm. *See* JP '597, paragraph [0042]. In contrast, the presently claimed invention provides a high-strength thick steel plate excellent in low temperature toughness at heat affected zone (HAZ) resulting from large heat input welding of more than 20kJ/mm, and having a thickness of at least 50 mm. One of ordinary skill in the art following the disclosure of JP '597 would have no reason to make or use the presently claimed high-strength thick steel plate.

In addition, JP '597 may generally discloses steels containing C: 0.03 to 0.09 percent, Si: ≤ 50.50 percent, Mn: 0.50 to 1.8 percent, p: ≤ 0.02 percent, S: 0.0010 to 0.010 percent, Al: 0.005 to 0.020 percent, Ti: 0.005 to 0.020 percent, N: 0.0020 to 0.0060 percent, and optionally contains one or more of Cu, Ni (≤ 1.5 percent), Nb (≤ 0.030 percent), V, Cr, Mo,

and B, and a balance of Fe and unavoidable impurities, and grains of multiple oxide of Ti and Al of more than 5 percent Ti and more than 95 percent of A, where the grain size is controlled to 0.01 to 1.0  $\mu\text{m}$  and the number of the grains is also controlled at  $5 \times 10^3$  to  $1 \times 10^5$  pieces/ $\text{mm}^2$ .

However, JP '597 fails to disclose any specific steel that falls within the scope of the present claims, and, thus, fails to provide any reason for those skilled in the art to make or use the presently claimed high-strength thick steel plate. JP '597 disclose only seven steels that contain titanium, nickel, and niobium simultaneously, steels 9 to 13, 15, and 21. *See* JP '597, Tables 1 and 3. Of those seven disclosed steels, only steels 10 and 11 contain nickel in an amount that falls within the scope of the present claims, and only steel 21 contains niobium in an amount that falls within the scope of the present claims. Steels 9, 12, 13, 15, and 21 contain an amount of nickel significantly less than the presently claimed amount of nickel, and steels 9 to 13 and 15 contain an amount of niobium as much as three times greater than the presently claimed amount.

In addition, of the seven steels disclosed by JP '597 containing titanium, nickel, and niobium simultaneously, only steel 11 contains an amount of aluminum that falls within the scope of the present claims. However, as discussed above, steel 11 contains an amount of niobium three times the presently claimed amount. Therefore, one of ordinary skill in the art following the disclosure of JP '597 would not make and/or use the presently claimed high-strength thick steel plate, and JP '597 fails to provide any reason for one of ordinary skill in the art to make and/or use the presently claimed high-strength thick steel plate.

With regard to the presently claimed heat input, the present invention requires a large heat input of more than 20 kJ/mm, because of a plate thickness of more than 50 mm. In contrast, JP '597 discloses a heat input of only 105 kJ/cm, which is equivalent to only 10.5 kJ/mm). The present invention allows the welding of a thick steel plate having a thickness of greater than 50 mm by one pass in a large heat input welding. Such welding is impossible without the HAZ toughness provided by the presently claimed invention.

Regarding the HAZ toughness of the presently claimed high-strength thick steel plate, the presently claimed high strength thick steel plate can be welded by one pass in with high heat input welding, such as electro-gas welding. It is difficult, if not impossible, to obtain sufficient toughness by refining  $\gamma$  grains caused by a fine dispersion of oxide, and, thus, it is necessary to improve the toughness of the base material. In this regard, the presently claimed invention provides sufficient toughness in the HAZ matrix by adding more than 0.8 percent nickel, and controlling the Ni/Mn value greater than the specific value determined with the

value of  $C_{eq}$ , as set forth in equation [1]. By controlling that value, the present invention provides the required toughness in the HAZ matrix.

In contrast to the presently claimed high-strength thick steel plate, JP '597 improves HAZ toughness by using a low heat input welding at around 10.5 kJ/mm by refining austenite grains at a heating temperature of less than 1400°C, utilizing ferrite formation in grains to be heated more than 1400°C near the welded bond, and utilizing finely dispersion of Ti-Al complex oxides having a diameter of 0.1 to 1.0  $\mu\text{m}$ . Thus, the presently claimed high-strength thick steel plate is patentably distinct from the steel disclosed in JP '597.

With regard to equation [1], as recited in claim 1, the Office Action states, "it is well settled that there is no invention in the discovery of a general formula if it covers a composition described in the prior art." In response, Applicants submit that, for the reasons set forth above, that the presently claimed high-strength thick steel plate is not "a composition described in the prior art." Without controlling the Ni/Mn value greater than the specific value determined with the value of  $C_{eq}$ , as set forth in equation [1], it is not possible to obtain the presently claimed high-strength thick steel plate. Therefore, "the selection of the proportions of elements: Ni, Mn, C, Cr, Mo, V, and Cu from JP '597 in order to meet the claimed equation" requires significantly more than a routine investigation by those skilled in the art. Thus, JP '597 provides no reason for one of ordinary skill in the art to make or use the presently claimed high-strength thick steel plate.

As JP '597 provides no reason for one of ordinary skill in the art to make and/or use the presently claimed high-strength thick steel plate, the present claims are not obvious over that reference. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 1 and 3 to 5 under 35 U.S.C. § 103(a) over JP '597.

EP '493 does nothing to overcome the deficiencies of JP '597. As discussed above, the only steel disclosed by JP '597 containing aluminum, titanium, nickel, and niobium simultaneously is outside the scope of the present claims. EP '493 discloses an aluminum content of .001 to .01 percent, and discloses that if the aluminum content of the steel exceeds 0.01 percent, the aluminum content in the oxide constituting IGF transformation nuclei is increased, and, as a result, the Mg content in the oxide falls below 10 weight percent, such that the precipitation of Mn-containing sulfide on the oxide particles is insufficient to allow the oxide particles them to lose their ability as IGF transformation nuclei. Thus, it becomes difficult to obtain the required 10 pieces/mm of IGF transformation nuclei in a stable manner. Accordingly, EP '493 teaches away from an aluminum content greater than 0.01 percent, and,

thus, teaches away from the presently claimed high-strength thick steel plate, and the combination of JP '597 and EP '493 is improper.

In addition, the presently claimed high-strength thick steel plate requires a heat input of more than 20 kJ/mm. In contrast, EP '493 discloses a significantly smaller heat input of 3.5 to 10.0 kJ/mm. The presently claimed high-strength thick steel plate provides welding of a thick steel plate having a thickness of more than 50 mm in a single pass in a high heat input welding at more than 20 kJ/mm, which is difficult to obtain with sufficient HAZ toughness. Therefore, EP '493, whether taken alone or in combination with JP '597, does not disclose or suggest the presently claimed high-strength thick steel plate, and provides no reason for one of ordinary skill in the art to make or use the presently claimed invention.

Therefore, as the combination of JP '597 and EP '493 is improper, and JP '597 and EP '493, whether taken alone or in combination, fail to provide any reason for one of ordinary skill in the art to make and/or use the presently claimed high-strength thick steel plate, the present claims are not obvious over those references. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claim 2 under 35 U.S.C. § 103(a) over JP '597 in view of EP '493.

Claims 1 to 5 stand rejected under 35 U.S.C. § 103(a), as allegedly being unpatentable over Japanese Application Publication No. JP 2003-313628 (JP '628) for the reasons set forth on pages 6 to 9 of the Office Action.

In response, Applicants submit that JP '628 discloses steel product having in toughness of a weld heat-affected zone, where the steel contains; C: 0.03 to 0.18 percent, Si:  $\leq 0.50$  percent, Mn: 0.40 to 2.0 percent, P:  $\leq 0.02$  percent, S:  $\leq 0.02$  percent, Ni: 0.6 to 4.0 percent, Nb: 0.005 to 0.10 percent, Al: 0.005 to 0.070 percent, Ti: 0.005 to 0.030 percent, Ca: 0.0005 to 0.0050 percent, N: 0.0005 to 0.0070 percent, B: 0.0005 to 0.0030 percent, and a balance of Fe and unavoidable impurities. The steel further has a value, ENI, which satisfies  $ENI \geq 0$  in a chemical equivalent expression:

$$ENI = \text{Ni percent} - 18 \text{ C percent} - 36 \text{ Nb percent} + 1,$$

and a value, EN, which satisfies  $-0.004 \leq EN \leq -0.0005$  in the chemical equivalent expression:

$$EN = \text{N percent} - 0.292 \text{ Ti percent} - 1.292 \text{ B percent}.$$

In addition, the disclosed steel has particles in the number of 100 to 3000 pieces/mm<sup>2</sup>, which have circle-equivalent particle size of 0.005 to 2.0  $\mu\text{m}$ , and contains at least Ca, Al, and O, as well as 3 percent or more Ca, 1 percent or more Al, on average mass percent of elements except O, and the balance the other deoxidized elements and/or unavoidable impurities.

The two equations are characteristic features of JP '628, and are directed to an intergranular ferrite for refining, i.e., pinning  $\gamma$  grains in HAZ portions with a fine dispersion of Ca-system oxides. The first equation is EN, which adds B to restrain the intergranular ferrite formation and a ferrite formation at the triple points of the grain boundary, i.e., intergranular ferrite, during HAZ structure formation, and to control the amounts of Ti and N for effecting the B addition. The Second equation is ENI, which is reportedly utilized to improve HAZ toughness caused by an increase in the limited resistance of hardened ferrite by the Ni addition, which is a different from the conventional idea becoming strengthening the matrix by the Ni addition, as, reportedly, the intergranular ferrite easily becomes a starting point for brittle fracture. Therefore, according to JP '628, the addition of appropriate amounts of Nb and C suppress an increase in the hardness of the intergranular ferrite with the Ni addition.

Thus, JP '628 discloses the restraint of intergranular ferrite formation and a decrease its effects, as a result of refining (pinning)  $\gamma$  grains at HAZ portions with a fine dispersion of Ca-system oxides. As discussed above, HAZ toughness is improved in the presently claimed high-strength thick steel plate in a manner that is patentably distinct from that disclose in JP '628.

With regard to equation [1], the Office Action again states that equation [1] fully depends on the composition of the disclosed presently claimed high-strength thick steel plate, and that it is well settled law that there is no invention in the discovery of a general formula where the formula covers a composition described in the prior art. In support of that statement, the Office Action applies equation [1] to the steel of example 6 of JP '628 to determine the Ni/Mn ratio of that steel using a value of  $C_{eq}$  determined from the composition disclosed in JP '628 for that steel.

However, the composition of the steel of example 6 of JP '628 is outside the scope of the composition of the presently claimed high-strength thick steel plate, and applying the equation for  $C_{eq}$  to example 6 provides a value of  $C_{eq}$  that is significantly greater than the range of  $C_{eq}$  recited in the present claims. The steel of example 6 of JP '628 contains 0.09 percent C, 0.23 percent Si, 0.094 percent Mn, 0.3 percent Cu, 3.05 percent Ni, 0 percent Cr, 0 percent Mo, 0.023 percent Nb, 0 percent V, and 0.017 percent Ti. Using those values in equation the equation for  $C_{eq}$  yields a  $C_{eq}$  value of 0.47; not 0.389, as stated in the Office Action.

That is,  $C_{eq} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$ , such that  $C_{eq} = 0.09 + 0.94/6 + (0 + 0 + 0)/5 + (3.05 + 0.3)/15 = 0.47$ . Again, the value of  $C_{eq}$  obtained

for the steel of example 6 of JP '628 is significantly greater than the presently claimed range of  $C_{eq}$ . As a result, the value of Ni/Mn of the steel of example 6 of JP '628 is not that of the presently claimed high-strength thick steel plate.

As discussed above, sufficient toughness in the HAZ matrix in the presently claimed high-strength thick steel plate is obtained by adding more than 0.8 percent nickel, and controlling the Ni/Mn value greater than the specific value determined with the value of  $C_{eq}$ , as set forth in equation [I]. By controlling that value, the present invention provides the required toughness in the HAZ matrix. The claimed value is not obtained with the steel disclosed in JP '628.

Thus, for the reasons set forth above, that the presently claimed high-strength thick steel plate is not "a composition described in the prior art." Without controlling the Ni/Mn value greater than the specific value determined with the value of  $C_{eq}$ , as set forth in equation [I], it is not possible to obtain the presently claimed high-strength thick steel plate. Therefore, "the selection of the proportions of elements: Ni, Mn, C, Cr, Mo, V, and Cu from JP '628 in order to meet the claimed equation" requires significantly more than a routine investigation by those skilled in the art. Thus, JP '628 provides no reason for one of ordinary skill in the art to make or use the presently claimed high-strength thick steel plate.

Finally, regarding the effect of the improvement of the HAZ toughness in the presently claimed high-strength thick steel plate, Examples Nos. D1 to D22, D25 to D26 and D35 to D45 in the present specification do not contain Ca, Mg, and REM, which JP '628 discloses are necessary to refine HAZ  $\gamma$  grains with a fine dispersion of oxides. The diameters of the grains in those examples of HAZ  $\gamma$  grains are typically greater than 400  $\mu\text{m}$ . In contrast, if HAZ  $\gamma$  in the steel disclosed in JP '628 are large, the HAZ toughness decreases significantly.

Thus, one of ordinary skill in the art following the disclosure of JP '628 would not obtain the presently claimed high-strength thick steel plate, and JP '628 fails to provide any reason for one of ordinary skill in the art to do so.

Therefore, as JP '628 fails to provide any reason for one of ordinary skill in the art to make and/or use the presently claimed high-strength thick steel plate, the present claims are not obvious over that reference. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 1 to 5 under 35 U.S.C. § 103(a) over JP '628.

Applicants thus submit that the entire application is now in condition for allowance, an early notice of which would be appreciated. Should the Examiner not agree with Applicants' position, a personal or telephonic interview is respectfully requested to discuss

any remaining issues prior to the issuance of a further Office Action, and to expedite the allowance of the application.

No fee is believed to be due for the filing of this Amendment. Should any fees be due, however, please charge such fees to Deposit Account No. 11-0600.

Respectfully submitted,

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